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DRAINAGE IN PELVIC SURGERY. THE USE OF THE SIPHON PUMP IN CONJUNCTION WITH CAPILLARITY.*

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In calling your attention to drainage in pelvic surgery, I do so with the intention of considering the subject only so far as will tend to make clear and commend to you an idea of my own.

When surgical work is done in the pelvic cavity, the desirability of allowing the free escape of deleterious discharges obtains, as regards the tissues involved, as it does upon the surface of the body; but there is this difference, when we have opened the abdomen and thereby laid bare the field of operation we have to work at the bottom of a cavity lined by a serous membrane of vast extent, rapidly absorbent and relatively intolerant. So here we have not only the ordinary surgical problem but another. In most cases, where the exudation of serum pus or blood is poured out upon a mucous or cutaneous surface, there is no necessity for drainage. The discharges are absorbed by the dressings. When we remove a tumor, separate adhesions, enucleate a pyosalpinx or open an abscess cavity, the same exudates are formed and the same changes occur as if these operations were done in a locality adjacent to a mucous or cutaneous surface. In the abdominal cavity, however, the intestines

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cover the wound and in fact form the dressing. By capillary attraction, the discharge is distributed over a wide area and the abundant vascular and lymphatic supply of the peritonæum aids its absorption. The danger in many cases is not the gravity of the operation done in the pelvis, but the exposure of the peritonæum to the action of an irritating or infectious discharge.

This difficulty is met in practice by work in two directions: on the one hand, by efforts to diminish the amount of the exudation by careful hæmostasis, by covering raw surfaces with peritoneal flaps and by strict regard to asepsis to prevent infection; on the other, by efforts to increase the absorptive power of the peritonæum and to cause the removal of the discharges by means of drainage.

We have now in common use two kinds of drains, the glass tube devised by Kœberlé and modified by Keith and the capillary drain of gauze introduced by Mikulicz. Is the drainage secured by either of these methods perfect, or can they be improved? Before answering this question, let us study the conditions present in the peritoneal cavity after an operation where there is a free secretion of a serous discharge mixed with a moderate quantity of blood and a glass drainage-tube has been placed in position. So far as I have been able to learn from the literature of the subject, the general conception of what takes place is as follows: The discharge is poured out and sinks to the lowest part of the pelvis, forming a small pool and rises in the tube to a corresponding extent. We pump out the tube with a long-nozzled syringe at longer or shorter intervals and believe that this is the whole story. But, it is not. Lying in contact with the pool of bloody serum are the intestines forming by the near apposition of their peritoneal surfaces capillary planes, between which the liquid rises to a height inversely proportional to the distance which separates them. As they are very close together, this height is considerable, besides there is no limit to the linear extension. So, in addition to the collection of serum in the lowest part of the pelvic cavity, there is an attenuated layer of indefinite extent enveloping the intestines. Nor is this all. Absorption by the serous membrane is constantly and rapidly going on and the loss at peripheral parts is continually being supplied by fluid coming from the center. In this way, there are developed currents starting from the pelvis and setting upward and outward and if pyogenic germs are present in the pelvis they are borne along with the serum and distributed widely over the peritonæum. When the tube is pumped out, the layer covering the intestines is removed in

great part because the cohesion of the fluid is stronger than the attraction of the surfaces, but it immediately begins to re-form before any collection occurs in the tube because the pool at the bottom of the pelvis represents the discharge produced in excess of the peritoneal absorption. So, in spite of our drainage the peritonæum is still the absorbent dressing of our wound. All we do is to remove some of the discharge and the peritonæum must do the rest.

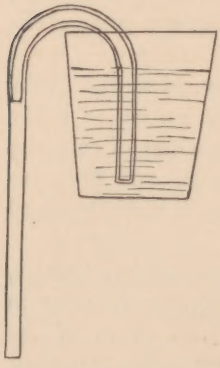
The same reasoning applies when we use the Mikulicz drain, although the drainage is continuous and not intermittent as is the case with the glass tube. For, here we have two systems of capillary drainage in operation, the gauze and the peritonæum, and the peritoneal has the advantage because the fluid does not need to be raised to the same height.

In one way or another, however, the abundant serous exudate, which acts both as a culture medium and a vehicle for the distribution of germs, must be removed. Drainage, therefore, by either of the existing methods is not perfect. From our standpoint, ideal drainage must supersede, not feebly supplement, the absorptive power of the peritonæum or what might be appropriately called natural drainage. When we can do this, as far as the discharges are concerned, we bring our field of operation to the surface of the body and an important element of danger will be overcome.

Six years ago, shortly after the completion of my term of service as an interne in the Woman's Hospital, New York city, I was engaged in assisting Dr. Nathan Bozeman in the preparation for publication of a description of some of his inventions. In this way I became interested in his drainage instruments for urinary fistula. They consisted of modified tubes which in some cases worked well and in other cases did not. In the hope of devising a more satisfactory drain for carrying off the urine from the vagina I began a series of laboratory experiments which led to the invention of the siphon pump. In the spring of 1889, I published in the *Atlanta Medical and Surgical Journal* an article entitled A New Pump and its Uses in Medicine, describing these experiments and the pump.

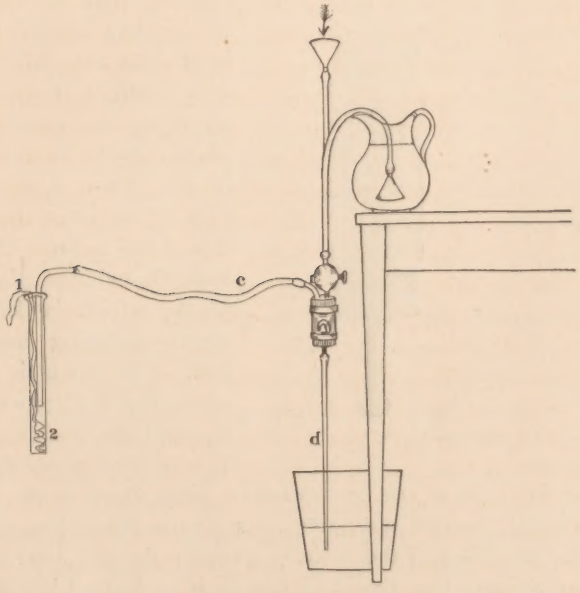
While referring you to the original paper for details, I will show one of the experiments because it helps to illustrate and explain the subject which we have now in hand. Recognizing capillarity as a force adapted to the purpose of collecting the urine, but finding that it could not be conveniently made to do so in sufficient quantity to keep pace with the secretion of the kidneys, I conceived the idea of

combining in the same instrument the power of capillarity and that of the siphon. In the following experiment this is done. A small short tube is put inside of a longer and larger one. The system of tubes thus formed is placed in a glass nearly full of water and one end is allowed to hang down forming a siphon as shown in the diagram. In virtue of the capillary attraction between the surfaces of the tubes the water rises until it passes over the edge of the glass and issues slowly from the extremity of the tube, drop by drop. These drops, descending through the tube like minute pistons, gradually expel the air; a partial vacuum is produced; the siphon starts and the glass is quickly emptied. Pursuing in this way the study of capillarity and the properties of the siphon, I finally devised the pump which I show you. It consists essentially of two siphons. The upper one supplies a sufficient quantity of water, which can be accurately regulated by means of a stopcock, to keep the lower one in operation, and only a very moderate quantity is needed. We have, therefore, a siphon which is continuously and automatically started and pumps air as well as water.



We possess in the pump a simple, convenient, constant and amply powerful means of exerting suction. But how is it to be used for purposes of drainage? If we carry the exhaust tube down to the bottom of a cavity, apart from the danger of doing harm, the suction will draw the tissues into the mouth of the tube, close the opening and defeat the end in view. The answer carries us back to our mysterious friend capillary attraction. Place a narrow piece of gauze several layers in thickness in a drinking glass, allowing one end to dip down to the bottom and the other to hang over the edge in the manner I show you, and then partly fill the vessel with water. If now the extremity of the glass exhaust tube of the pump be pressed against the gauze half an inch or more above the level of the water, the fluid will be quickly drawn into the tube and the glass will be rapidly emptied. Moreover, if the action of the pump be continued, the gauze will soon become practically dry. This experiment is so important that we must stop to study what takes place within the gauze. The gauze consists of many minute intercommunicating spaces forming capillary tubes arranged in planes both vertical and horizontal. In

virtue of capillarity, these tubes become full of water. When the exhaust tube of the pump is placed in contact with the gauze, a partial vacuum is produced and the water it contains is drawn into the tube. The loss is quickly supplied by fluid, rushing in from more distant parts to take its place. The capillary tubes in fact become a continuation of the exhaust tube. There is this difference however, when the supply of water in the gauze is not sufficiently abundant to keep

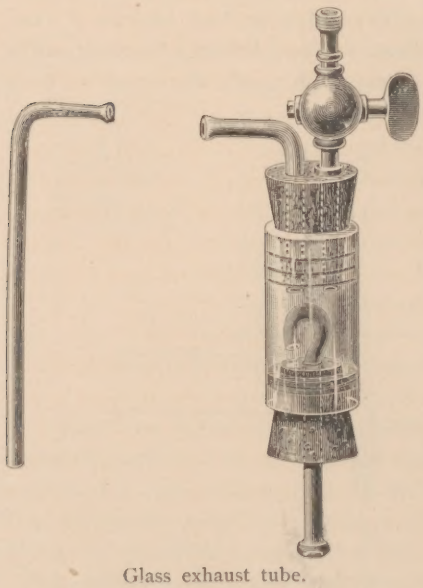


The siphon pump.

pace with the pump, the suction increases and air is drawn through the gauze. It will therefore be seen that the force of the suction exerted by the pump can never exceed the resistance afforded by two or three layers of gauze to the passage of air, a force so slight as not to be injurious to the most delicate tissues and, besides, this force is exerted upon the gauze and not upon the tissues.

The manner in which I have used the pump can readiiy be understood from what has been said. All that is required is an ordinary Keith's drain, a piece of glass tubing about an eighth of an inch in its internal diameter, bent as shown in the figure, some long narrow

strips of iodoform gauze and the pump. The drainage-tube is placed in position at the time of the operation and, after the patient has been put to bed, a strip of the gauze is placed in the tube and loosely packed in the bottom so as to form a layer a third or half an inch in thickness, care being taken to keep one end of the strip at the upper extremity of the tube so that the gauze can be readily removed. The bent glass tube, which is also a convenient instrument for adjusting the gauze, is now passed down to the bottom of the drain so as to press closely against the gauze. The tube is now connected with the exhaust pipe of the pump, which is kept constantly working beside the bed. The whole is covered with a layer of absorbent cotton, and the binder adjusted. The strip of gauze should be removed at intervals of one or two hours, when there is much blood in the discharge, because the pores are apt to become clogged up.



Glass exhaust tube.

That the efficiency of the drain is wonderfully increased and that the serous discharge is removed as fast as it is formed is a matter of simple demonstration but, while overcoming some of the difficulties of the problem, have we introduced any new elements of danger? I think not. No harm can certainly come from the introduction into the drain of a strip of iodoform gauze and a straight glass tube, which can be rendered perfectly aseptic. It is true that a current of air is drawn through the apparatus, but it is filtered by the cotton dressing and does not come in contact with the tissues but only with the surface of the gauze.

At the present time I am unable to furnish any statistical arguments to enforce what I have said. Time, and experience in the hands of others, alone can make these of any value. As yet, I have employed this method of drainage in only one case but, as far as it is

possible to judge from one case, the result was very satisfactory. The case in itself being of interest, I will briefly relate it:

A Case of Supravaginal Hysterectomy for a Large Fibro-cystic Tumor Complicated by many Adhesions; Recovery from the Operation; Occurrence of Acute Strangulation of the Intestine from Bands on the Fifty-eighth Day, followed by Death on the Sixty-fourth; Autopsy.

Fanny Peters, colored, laundress, aged forty-two, married, nullipara, applied to me for treatment May 3, 1893. She said that she had had a tumor for ten or twelve years, but that it had increased in size very rapidly during the past two. She also gave a history of several attacks of peritonitis which confined her to bed for months and complained of pain from distention of the abdomen and pressure on the rectum, bladder and diaphragm.

Examination showed a fluctuating tumor of great size.

Operation May 22d, present and assisting Drs. Holt, McHatton, Williams, Derry and Barron. When the abdomen was opened and a large quantity of clear watery fluid drawn off, the sac was found to have very thick walls and to be continuous below with a large fibrous mass springing from the uterus. On the anterior surface of the tumor were many threadlike adhesions which were readily separated, but above and posteriorly the adhesions were almost complete. After a tedious dissection partly with the fingers, sometimes with a knife, laying bare many square inches of the intestine and involving the handling of the common iliac vessels, I managed to separate the tumor down to a point a little below the brim of the pelvis. I then desisted. What remained of the sac was stitched to the abdominal wall and packed with iodoform gauze. The solid portion of the tumor was ligated with a rubber ligature, supported by knitting-needles and fastened in the wound, the wound closed, a Keith's drain introduced into the abdominal cavity and after the patient had been put to bed the strip of gauze and glass tube connected with the pump was placed in position in the manner already described. During the first forty-eight hours, a very considerable quantity of bloody serum was removed. At the end of this time the use of the pump was discontinued owing to the cessation of the discharge. During the first two weeks the patient had a fever ranging from 99.5° to 102° due to absorption from the discharge from the sac and the stump, but there were no symptoms of peritonitis. After this time the temperature gradually declined to normal, the patient gained appetite, flesh and strength and

was able to sit up and go around the house. On the fifty-eighth day after the operation, following a large and indigestible meal, the patient was seized with vomiting and severe pain in the abdomen. I found her, an hour later, in a condition of profound shock. On the third day, although the vomiting never became stercoraceous, I was convinced of the diagnosis of complete obstruction of the bowel, but soon afterward the pulse became so weak that it was thought best not to do any operation. Death occurred on the sixty-fourth day. The autopsy disclosed the following conditions: Complete occlusion and collapse of the small intestine below a point about three feet above the ileo-cæcal valve, caused by the entrance of two loops of intestine into a narrow opening formed by a band extending from the mesentery to the free surface of intestine. There were a number of these bands present even as high up as the diaphragm and it was evident that they had nothing to do with the operation but were the result of old attacks of peritonitis of which the patient had had several.

In conclusion, I would like to add that in regard to the instruments described, if only they will excite sufficient interest among the profession, I invite modification and improvement. I wish mainly to impress upon you the principles which underlie them. They are those of the continuously-acting siphon, which pumps air as well as water, and the employment of the suction force thus generated for the purpose of draining fluids from dependent localities in conjunction with capillarity in the manner described.